

# Characterization of the Sanitary Condition of Sales Points for Garba Fried Tuna and Braised Fish Tilapia in Abidjan's District

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**Abstract** Food-borne infections are a major public health problem worldwide. In Côte d'Ivoire, street food remains a major problem due to the deterioration in its quality and failure to comply with hygiene conditions. This descriptive epidemiological study was initiated to assess the health conditions of tuna (Garba) and braised fish sales points in the district of Abidjan. Systematic sampling was carried out in the various tuna (garba) and braised fish sales points in the district of Abidjan. The sampling sites were chosen according to the division of the district of Abidjan into enumeration zones by the national statistics institute. Sampling was carried out over the period from March to August 2021. The survey was conducted using a questionnaire that had been designed in advance and digitized on the ODK application. Only accessible sales points with sales staff available to answer the questionnaire were selected. Descriptive statistics were produced using R.2.0 software. 194 sales points (95 tuna sales points and 99 tilapia sales points), grouped into 5 zones, were selected from the 40 enumeration zones of the 11 municipalities in the Abidjan district. The socio-demographic characteristics of the sellers, cooking techniques used for various species of fish and a qualitative assessment of the health of the sales points were determined. Overall, the marketing of tuna (garba) and braised fish in the Abidjan district shows a high level of precariousness and a lack of hygiene, which could be the cause of microbiological contamination of these foods sold to the Abidjan's population.

**Keywords:** tuna, tilapia, sanitary condition, health, environment, Street-food, Côte d'Ivoire

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## 1. Introduction

Rapid urbanization in Abidjan has led to a population influx that has made the Ivorian capital one of the most densely populated cities in the Economic Community of West African States (ECOWAS). The need to feed this population is posing increasing difficulties in terms of availability, accessibility, and food safety. The urbanization of the city of Abidjan has led to the development of out-of-home catering in recent decades. An observation by the UN Food and Agriculture Agency (FAO) carried out between 1987 and 1995 showed that 52% of the population in Abidjan had used food away from home at least once a day [1]. The trend in these figures is upwards. While this lifestyle seems to provide solutions in terms of food availability, it could also create problems in terms of food safety.

One third (9 million / 29 million) of the Ivorian population lives in Abidjan [2], and to feed this population, several public catering systems have been developed for all social categories. These public catering outlets offer a wide variety of foods, including traditional local and foreign dishes. These include cassava semolina "Attiéké" with tuna fish called "Garba" and braised fish.

Ensuring safe food quality in public catering is becoming a public health obligation [3]. In general [4], the quality of a food product is defined by Safety (hygienic quality), Health (nutritional quality), Satisfaction (organoleptic quality) and Service (quality of use: ease of use, suitability for processing, price). Managing these different quality criteria during the processing and preservation of fish sold in Abidjan's public catering sector will help to ensure food safety for consumers. The aim of this descriptive epidemiological study is to assess the health status of sales points for tuna (Garba) and braised fish in the district of Abidjan.

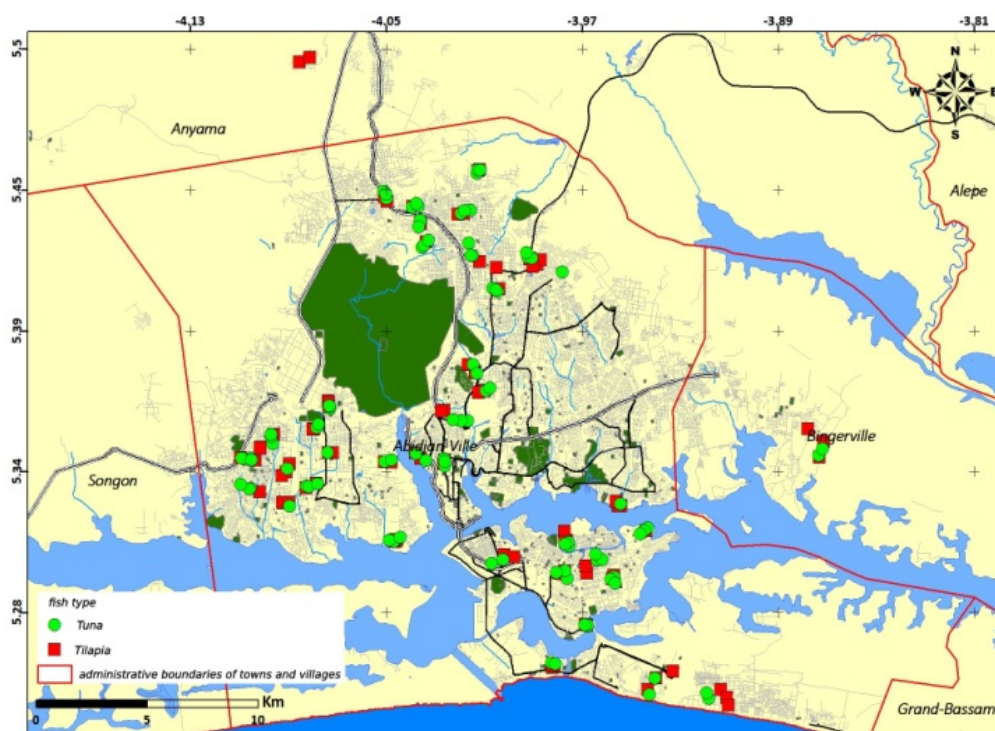


Figure 1. Spatial distribution of tuna and tilapia sampling sites in the Abidjan district

## 2. Materials and Methods

### Study sites

Sampling was carried out systematically at various sales points (frying and braising) in the district of Abidjan, based on maps of the Abidjan district census area obtained from the *National Institute of Statistics* (INS, general population census). The study focused on Tilapia and Tuna fish in their most popular prepared forms in Abidjan, grilled Tuna fish and braised Tilapia fish, based on 40 enumeration areas [5], surveys were carried out to identify all the sales points in these areas, which will serve as a basis for our sampling. The municipalities concerned were: Yopougon, Abobo, Cocody, Treichville, Port-Bouët, Attécoubé, Marcory, Anyama, Koumassi, Bingerville and Adjamé.

### Sampling

During the period from March to August 2021, surveys were carried out in 11 municipalities in the District of Abidjan. The criteria for choosing these enumeration areas were, firstly, the presence of sellers to be interviewed, their availability to answer questions, and lastly the accessibility of the area (Figure 1).

### Conduct of the survey

Data collection was based on a socio-health survey, from 17 March to 31 August 2021. The survey was based on field observations and interviews with the staff of existing sales points. To achieve this, a questionnaire was divided into two (2) parts: firstly, the socio-demographic parameters of the survey, and secondly, the health parameters linked to the main activity were addressed, considering the general hygiene guidelines of the *Codex Alimentarius* [6]. Questionnaires were digitized and used with ODK software to facilitate the survey [7].

Overall, there were 40 enumeration zones and 194 collection points (95 tuna collection points and 99 sales points for tilapia) (Table 1), grouped into 5 zones (Table 2): zone 1 (Abobo and Anyama), zone 2 (Adjamé and Attécoubé), zone 3 (Yopougon municipality only), zone 4 (Koumassi, Marcory, Treichville and Port-Bouët) and zone 5 (Cocody and Bingerville).

Table 1. Distribution of collection points by municipality

Municipality	Number of counting zones	Number of collection points
Abobo	8	45
Adjamé	4	15
Anyama	2	2
Attécoubé	3	8
Bingerville	1	5
Cocody	3	13
Koumassi	3	23
Marcory	3	12
Port-Bouët	3	15
Treichville	1	5
Yopougon	9	51
Total	40	194

Table 2. Grouping of municipalities into zones

Zone	Municipality	Number of collection points
Zone 1	Abobo, Anyama	47
Zone 2	Adjamé, Attécoubé	23
Zone 3	Yopougon	51
Zone 4	Koumassi, Marcory, Treichville, Port-Bouët	55
Zone 5	Cocody, Bingerville	18
Total	11	194



### Data analysis methods

Qualitative and quantitative data were coded and analyzed to produce descriptive statistics. These variables were expressed as percentage frequencies. All these analyses were carried out using R.2.0 software. [8].

A Multiple Correspondence Analysis (MCA) was carried out to check the segregations of individuals in a factorial plan according to the qualitative variables with the packages factomineR, ggplot2 and Ade4. This analysis was carried out by transforming the data matrix made up of 11 parameters into an hclust data. Determination of the optimum number of groups was carried out using the fastcluster package, with the *best.cuttree* function. This function calculates the best partition to cut a dendrogram based on the highest relative inertia loss criterion.

## 3. Results

### Socio-demographic characteristics of sellers

The socio-demographic characteristics of the sellers mainly concerned gender, the type of gender according to the species sold, and the distribution of fish species sold according to area. Table 1 shows the distribution of fish sales point owners by municipality and gender. Most of these traders were men (57% and 52% respectively in zones 1 and 2) and women (53% in zone 3 and 4 and 72% in zone 5). These sellers were divided by sex according to the type of fish sold, with 95 sales points for tuna fish and 99 for tilapia. In zone 5, 17% were women selling tuna (garba), while 0% were women in zones 1, 2, 3 and 4. For the braised tilapia species, 100% were women in all zones (Table 2). Table 3 shows the trend in species sold by zone. The sale of braised fish (tilapia) accounted for 53% of sales in zones 3 and 4, and 66% in zone 5. However, we have a majority of 57% and 52% in zones 1 and 2 for the sale of garba (tuna).

### Preparation techniques for different species of fish

The surveys showed that the two species of fish with the highest economic value were prepared on the different sites according to the survey period. These species, which are the most widely consumed in the Abidjan district, are generally "false tuna" for tuna fish and *Oreochromis niloticus* for braised fish. The method used to prepare these fish at all the sales points was the traditional method. This method differed according to the species surveyed and involved different stages: for tuna (Figure 2), the first stage involved buying fresh fish, often already cut up, from wholesalers. The second stage involved cleaning the purchased fish, after which they were placed in a bowl to be flour-coated. The third stage involved preparation. The fish were placed in oil, very often already re-used, heated in a frying pan. The fourth stage consisted of removing the fish from the oil, often by the customers themselves or with the help of the seller, using a skimmer or forks, then putting it on a plate outstanding to be served.

For tilapia (Figure 3), the first stage involves buying the fresh fish from wholesalers, which are usually sold in boxes for lagoon fish or individually for freshwater fish. Once the display was ready, the second stage consisted of either displaying the fish in a tray to await an order before cleaning or braising; some were cleaned and then the fish

were placed on a grill for braising. The third stage involved preparation. The fish were turned on each side until they were cooked to the optimum according to the restorer. The fourth stage consisted of removing the fish from the grill with the hands or a spatula, then putting it on a plate and serving it to the customers.



Figure 2. Tuna fish frying stage (Photo Pascale Djaman)



Figure 3. Tilapia fish braising stage (Photo Pascale Djaman)

### Qualitative assessment of the health of sales points

The level of hygiene at each sales point and the level of hygiene of the sales staff were assessed according to the criteria (Satisfactory, Acceptable, Unsatisfactory), as well as whether compliance measures were in place, such as certification and training. The results of the survey showed that the sector is encountering environmental and health safety problems. The survey highlighted the generally unsatisfactory level of cleanliness (Table 4) outside the sites (presence of gutters, run-off water, construction, or other activities that could have negative impacts on the quality of the food), inside the sites (interior layouts generally without apparent separation depending on the equipment, wooden or wall construction but not clean with dirt, traces of oil, etc.), waste management (presence of overflowing dustbins, or no

dustbins). These sellers, who very often do not have a high level of education, have hygiene certificates but no training (Table 6). Sellers or sales point managers generally do not wear clean and intact clothing, and hand-washing facilities are often carried out in bowls full of water that is not renewed and lasts all day (Table 5). The results showed that none of the sales staff interviewed really observe the rules of hygiene in terms of food safety in these activities.

**Table 1. Determination of the gender of sales point owners by zone**

Sexe	Zone 1(%)	Zone 2(%)	Zone 3(%)	Zone 4(%)	Zone 5(%)
Men	27 (57)	12 (52)	24 (47)	26 (47)	5 (28)
Women	20 (43)	11 (48)	27 (53)	29 (53)	13 (72)
Total	47 (100)	23 (100)	51 (100)	55 (100)	18 (100)

**Table 2. Gender distribution of tenants by zone, by species sold**

Fish	Sexe	Zone 1 (%)	Zone 2 (%)	Zone 3 (%)	Zone 4 (%)	Zone 5 (%)
Tilapia	Men	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Women	20 (100)	11 (100)	27 (100)	29 (100)	12 (100)
Tuna	Men	27 (100)	12 (100)	24 (100)	26 (100)	5 (83)
	Women	0 (0)	0 (0)	0 (0)	0 (0)	1 (17)

**Table 3. Distribution of species sold by zone**

Fish	Zone 1 (%)	Zone 2 (%)	Zone 3 (%)	Zone 4 (%)	Zone 5 (%)
Tilapia	20 (43)	11 (48)	27 (53)	29 (53)	12 (66)
Tuna	27 (57)	12 (52)	24 (47)	26 (47)	6 (34)
Total	47 (100)	23 (100)	51 (100)	55 (100)	18 (100)

**Table 4. Hygiene level of sales points**

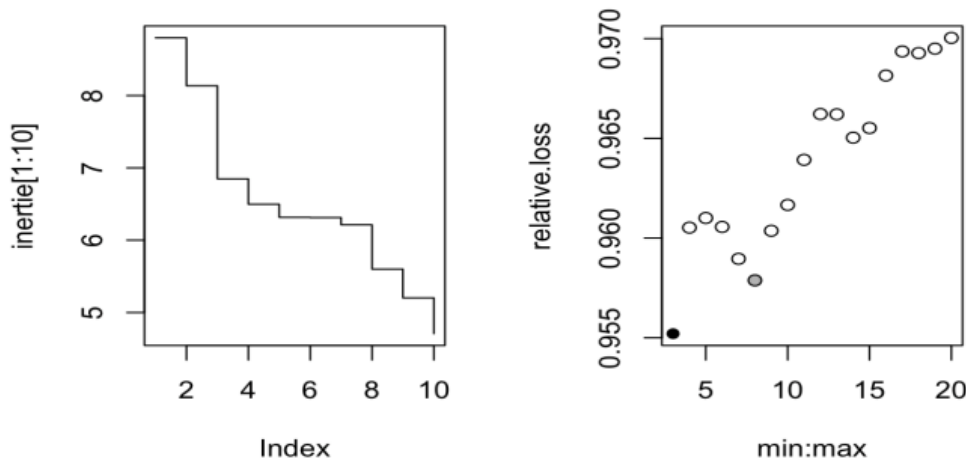
	Modality	Zone 1 (%)	Zone 2 (%)	Zone 3 (%)	Zone 4 (%)	Zone 5 (%)
Internal site hygiene	Satisfactory	3 (7)	1 (4)	7 (14)	21 (38)	4 (22)
	Acceptable	17 (36)	16 (70)	27 (53)	16 (29)	13 (72)
	Unsatisfactory	27 (57)	6 (26)	17 (33)	18 (33)	1 (6)
External site hygiene	Satisfactory	1 (2)	0 (0)	7 (13)	0 (0)	1 (2)
	Acceptable	10 (21)	7 (31)	8 (16)	15 (27)	4 (22)
	Unsatisfactory	36 (77)	16 (69)	36 (71)	40 (73)	14 (78)
Waste management	Satisfactory	0 (0)	0 (0)	2 (4)	0 (0)	2 (11)
	Acceptable	0 (0)	0 (0)	5 (10)	0 (0)	0 (0)
	Unsatisfactory	47 (100)	23 (100)	44 (86)	55 (100)	16 (89)

**Table 5. Hygiene level of sellers**

	Modality	Zone 1(%)	Zone 2(%)	Zone 3(%)	Zone 4(%)	Zone 5(%)
Cleanliness of work clothes	Satisfactory	8 (17)	3 (13)	7 (14)	12 (22)	3 (17)
	Acceptable	17 (36)	5 (22)	23 (45)	16 (29)	10 (55)
	Unsatisfactory	22 (47)	15 (65)	21 (41)	27 (49)	5 (28)
Hand washing and sanitization	Satisfactory	0 (0)	0 (0)	4 (8)	0 (0)	0 (0)
	Acceptable	0 (0)	0 (0)	8 (16)	0 (0)	0 (0)
	Unsatisfactory	47 (100)	23 (100)	39 (76)	55 (100)	18 (100)

**Table 6. Presence of hygiene certificate and training**

	Modality	Zone 1(%)	Zone 2(%)	Zone 3(%)	Zone 4(%)	Zone 5(%)
Training	Yes	0 (0)	0 (0)	3 (6)	0 (0)	0 (0)
	No	47 (100)	23 (100)	48 (94)	55 (100)	18 (100)
Certificate	Yes	0 (0)	1 (4)	18 (35)	0 (0)	0 (0)
	No	47 (100)	22 (96)	33 (65)	55 (100)	100 (18)



**Figure 4.** Determining the optimum number of groups

**Multiple component analysis**

The discrimination of different classes was carried out with a partitioning algorithm using the higher inertia relative loss criteria method. Figure 4 shows the jumps in inertia obtained from the transformation of the matrix of qualitative variables into hclust class objects. Analysis of this figure shows that the optimum number of groups is three. Group 1 is made up of 11 people, group 2 of 54 people and group 3 of 129 people.

The variables that contribute most to the formation of axis 1 are "gender", "type of fish sold" and "workplace hygiene". The first two variables are highly correlated. Axis 2 had the variables with the strongest contributions, in descending order, possession or not of a certificate, waste management and hand hygiene (Figure 5). These axis results represent 14.404% and 13.136% of inertia respectively, or a cumulative 27.54% of the variability observed in our population (Table 7).

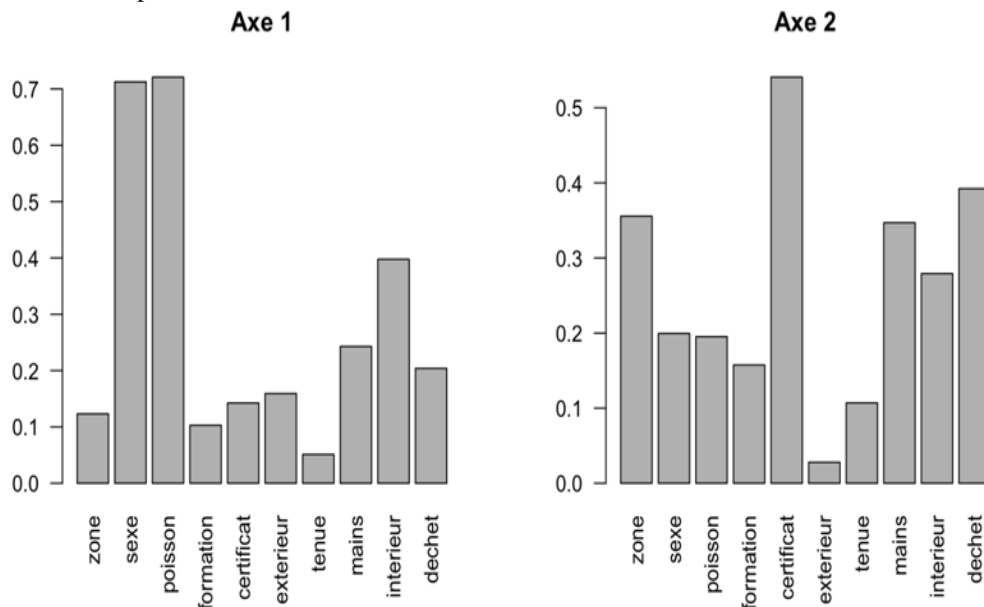
The individuals in our sample are represented as points in two factorial planes of the multiple component analysis. The first is composed of factorial axis 1 and factorial axis 2, while the second is composed of factorial axis 2 and 3.

The three observed colours represent the two groups obtained from the partitioning method. The red individuals represent group 1, and the blue individuals represent group 2 (Figure 6).

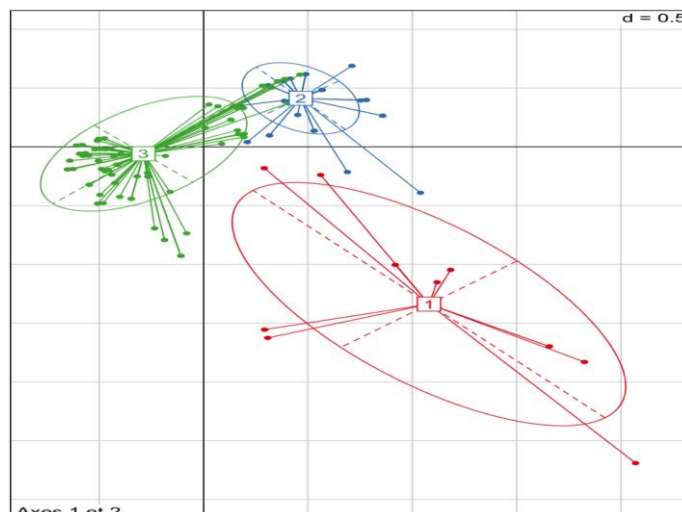
The representation of the individuals in the first factorial plane shows no discrimination of the population studied. The same is true of the projection into the factorial plane, taking zone as a factor. If the possession or not of a hygiene certificate makes it possible to discriminate relatively between two groups, those who have one constitute a tiny part of the population. Only gender and type of fish can be used to distinguish two different, virtually identical groups (Figure 7).

**Table 7. Eigenvalues and percentage of inertia according to the different MCA axes**

	Axe 1	Axe 2	Axe 3	Axe 4
Fish				
Net Asset Value	0.2882	0.2628	0.1623	0.1447
Percentage of inertia	14.404	13.136	8.113	7.233
Cumulative percentage of inertia	14.40	27.54	35.65	42.89



**Figure 5.** Contribution of the different variables to the formation of axes 1 and 2 of the MCA



**Figure 6.** Projection of individuals onto the factorial plane consisting of axes 1 and 2, using the best partition obtained as the discrimination factor

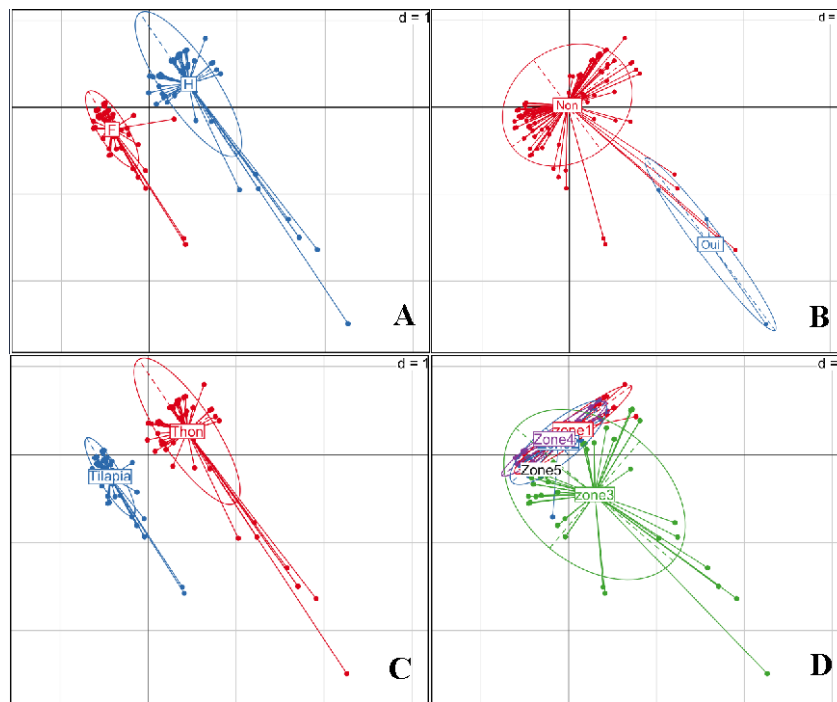


Figure 7. projection of individuals onto the factorial plane consisting of axes 1 and 2

A) the variable gender is used as a discriminating factor; B) the variable possession of a hygiene certificate is used as a discriminating variable; C) the variable marketed fish is used as a discriminating factor; D) the variable area is used as a discriminating variable.

#### 4. Discussion

In the city of Abidjan, out-of-home food consumption is a widespread phenomenon that mainly takes place after purchase from street sellers [9]. Among the multitude of foods consumed in the street, 'Garba' and 'braised fish' are the focus of our study. The first dish is essentially made up of tuna fish and attiéké, while the second is made up of tilapia cooked over charcoal on a grill. This study revealed that all the sellers of "braised fish" were women and most of the sellers of "garba" were men, apart from one sales point where women were present. These results are in line with those of [10]. The first author revealed the predominance of men in the marketing of 'Garba' in the municipality of Yopougon, with a frequency of 94%. As for the second, he revealed that historically the popular catering sector was dominated by women. The sale of "Garba" and grilled meat "choukouya" seems to be the only popular catering sector reserved for men [11].

Garba preparation techniques have been described by several authors [12]. This dish, which consists of attiéké, tuna fish, is a typically Ivorian meal that is quick, cheap, and popular with all sections of the population. Some authors have also revealed the repeated use of oil for frying fish, with up to six days of frying with the same oil and 14.44% frying even more with the same oil until it is completely blackened [13].

Although there have been previous studies on 'garba', this is not the case for tilapia-based street food. This study is therefore a pioneering one in describing the process of making tilapia-based street food in Côte d'Ivoire. Whether

tilapia or tuna is involved, the actors interviewed all fall into the category of street food.

According to the [14], street food is a factor in food-borne diseases, which not only affect the health and well-being of the population, but also have economic repercussions for individuals, families, communities, businesses, and countries. This would be due to a glaring lack of hygiene practices in this area of activity, as observed in our study, or the condition of cleanliness of the sales point, the washing of utensils and the quality of drinking water. On the other hand, the upkeep of the dustbin, the place to evacuate wastewater near the sales points, the precautions taken to protect attiéké and fish, the washing of hands and utensils, the availability of toilet paper, the quality of towels used, and the use of frying oil were all studied. Our results show that these parameters are not linked to the zone. Also, [15] revealed that variations in these parameters in general are not linked to the level of education of "garba" sellers. The results obtained corroborate the fact that the obtaining of a hygiene certificate by some sellers was not correlated with the application of hygiene practices. However, the issuing of this document by the health authorities after evaluation should determine the practice of a certain number of food hygiene guidelines. In other cases, whether the "garba" seller can read and write, this does not have a positive influence on certain practices. In other words, they do not observe good food hygiene practices [15].

Studies conducted in Côte d'Ivoire have revealed that the municipality's street food restaurants have inadequate sanitary facilities and poor waste management [16,17]. This finding is also revealed by our study. Thus, while the hygiene inside the site has its strong points, hygiene outside and waste management were also found to be unsatisfactory in almost all the sites visited. This situation may be due to a lack of adequate sanitation facilities or poor management of these facilities, as mentioned by Kinfe [18] and Mendedo [19]. This poor management



could create conditions conducive to the multiplication of insects. This would lead to cross-contamination of food and utensils.

There is also a logic behind the location of the sites: as the aim of the activities is to obtain cash, the points of sale are chosen based on this concern for profitability. The search for proximity to customers would explain this situation [20,21].

However, they constantly mention the lack of hygiene that characterizes its marketing and consumption. The results of our study show that the rules of food hygiene are absent from most sales points. These results are like those of [15].

The discrimination revealed by the MCA is linked to the types of fish used in the preparation of these dishes. The type of dish also depends on the sex of the individuals surveyed, as the survey revealed that tilapia is cooked exclusively by women and tuna almost exclusively by men.

## 5. Conclusion

This work to characterize the sanitary conditions of sales points for fried tuna (garba) and braised tilapia fish has highlighted the precarious nature of the system for selling these delicacies in the district of Abidjan. Regarding the socio-demographic characteristics of sellers in the 11 municipalities (5 enumeration areas) visited, it emerged that selling garba was heavily dominated by men, while selling braised fish was exclusively dominated by women, regardless of the municipality. Fried tuna (garba) and braised tilapia fish are sold in all the municipalities visited, which underlines the importance of these two dishes in the eating patterns of Abidjan's population. In terms of preparation techniques for the various species of fish, the survey revealed a standard preparation technique common to all the enumeration areas, depending on the type of dish. The qualitative assessment of the sanitary conditions of the sales points showed that the sanitary conditions for the sale of fried tuna and braised tilapia fish were unsatisfactory, both in terms of the management of the sales points and the management of the waste produced during the sale. It should also be noted that sellers' hygiene is rather poor, except in the Cocody - Bingerville area (zone 5), where sellers have an acceptable level of clothing hygiene. Hand-washing conditions were unsatisfactory in the 11 municipalities visited. Finally, the work revealed the presence of health certificates in certain sales points in the municipality of Yopougon (zone 3). As a result, training and regular inspection visits by the health authorities would not only help to assess the health risks involved in preparing and selling food but would also raise awareness and encourage sellers to improve the hygiene of their sales outlets for the health of the consumer population.

## Authors' Contributions

All the authors contributed effectively to this work at one level or another. DP and KKY carried out the surveys and interviews with fish restaurants under the supervision of KCS, who directed the work. The four authors contributed actively to analyzing the results and writing the article.

## Conflict of Interest

All the authors declare that they have no conflict of interest.

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